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VII.—*On the Physical Geography of the Red Sea.*

By Dr. Buist, of Bombay, F.R.G.S.

Read April 10, 1854.

Boundaries.—The Red Sea is one of the most remarkable estuaries on the surface of the globe; separating the N.E. portion of Africa from Arabia for the space of above 1280 miles, it seems at no very remote period to have been connected with the Mediterranean. Opening into the Indian Ocean, through the Gulf of Aden, it commences at the Straits of Babelmandeb, lat. 12° 30′ N., long. 43° 40′ E., extending in a north-westerly direction till it terminates in the two Gulfs of Akabá and Suez, the upper extremity of the former being in lat. 29° 36′ N., long. 35° 2′ E., that of the latter in lat. 30° 2′ N., long. 32° 38′ E. From the Strait to Suez in a direct line is 1230 miles; the greater strait itself measures in breadth 13 miles, the lesser 1¾ miles; the two together, which constitute the entrance to the sea, 14¾ miles, or including the island of Perim, which separates them, 16¼ miles. Its entire circuit measured round both gulfs is 4020 miles, its area 108,154 miles, and its cubic content probably about 800,000 miles.* Its greatest breadth under the parallel 17° N., that is one-third up the sea, is 192 miles, and it narrows pretty uniformly towards both extremities, being 72 miles across at Ras-Mahommed, where the peninsula of Mount Sinai splits its upper extremity into two, and nearly a similar breadth at Gibbel Zugar, under the 14th parallel.

Gulf of Suez.—The Gulf of Suez from its upper extremity to its entrance is 167 miles in length; its greatest width is under 30; at its mouth it is about 17 miles from shore to shore; its area in all is about 2000 square miles. Its greatest depth is about 50 fathoms, its average about 22; excluding the shallows at Suez, it occupies from 8 to 10 miles at its upper extremity.

Gulf of Akabá.—The Gulf of Akabá is about one-third the area of that of Suez, or 800 miles; it is 100 miles in length, 16 across at the widest, and 7 at the strait. It is more than double the depth of its sister gulf, being about 120 fathoms for two-thirds of its length, reaching at one point the depth of 200 fathoms without bottom. Its mean depth altogether is probably not less than 70.

Depth of the Red Sea.—Although two-thirds of the area of the Red Sea have never been sounded, and no sufficient data exist from which to form a judgment of its depth, there is no reason to believe it to be very great. There are soundings all around its shores from 10 to 20 miles out from Judda, in lat. 21° 30′, to the approach of the volcanic region in lat. 17°, and frequent cross soundings have been obtained from this southward to the strait. From 21° to 27° 30′, or for nearly 400 miles in length, there is a space from 50 to 70 miles in breadth, or an area of about 20,000 miles, that seems never to have been sounded; and this part has never been examined since the original survey was made 20 years ago. Being free from islands, reefs, and shoals, it occasioned no alarm to the navigators, and the surveyors had no time to devote to mere questions of physical geography. The greatest depth that seems ever to have been tried is 400 fathoms, lat. 25° 20′, at which no bottom could be found; and there appears to be a gulf from 5 to 10 miles wide down the centre of the sea, varying from 150 to 250 fathoms, with abrupt and precipitous sides. The average depth of the central region of the sea to an extent of about 40 miles or so may probably be about 100 fathoms; the average depth of the whole sea probably falls short of 40. A reef or shallow runs across from Mocha, lat. 13° 30′, to the African shore; it has been very carefully sounded all along; it affords an average depth of from 25 to 30 fathoms; its greatest depth being 40, near mid-channel. From this the sea deepens again to 125 fathoms* as it approaches the strait. The great strait, as already mentioned, is 16 miles across; its average depth is about 80 fathoms, its greatest 125; and for a breadth of nearly 6 miles in mid-channel the depth exceeds 100 fathoms. The narrow channel being that which vessels from Aden almost always prefer in ascending the Red Sea, varies from 12 to 17 fathoms in depth, but there is 30 feet of water up to both shores with a fine sandy bottom, so that navigators feel no apprehension in traversing it at any hour. The Gulf of Aden, which continues the communication from the Straits to the Arabian Sea, is a funnel-shaped estuary above 900 miles in length and nearly 200 across from the N.W. point of Africa to the Arabian shore. Its general characteristics are similar to those of the lower part of the Red Sea—it is remarkable for the violence of its currents, which will be noticed afterwards, and for the depth of its central channel and shallowness of its shores.

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* The figures representing area, circumference, and content are to be received as approximations merely—especially the circumference; the area will probably be found not very far from truth.

The Tides at Suez are about 5 feet at neap and 7 at spring. The rise and fall at Ras-Mahommed is about 5 feet—high water at 6 o'clock. The direction of the wind makes a difference of about 4 feet in the depth of the water near Suez: the banks which are left dry by the N. wind are well covered with a breeze from the S. We know little of the tides over the rest of the sea. At Aden, 80 miles without the strait, where continuous observations have been taken by gauge for three years, the tides rise 4 feet at neaps, and nearly 8 at springs; high-water occurring at 1·30; the sweep of the tides, as well as the hour of high-water, being remarkably irregular. The Red Sea probably derives its name from large portions of it, as well as of the Arabian Sea, being covered with patches, from a few yards to some miles square, of a blood-red colour, derived from a species of animalculæ particularly abundant in the spring months, and which dye the upper waters of the most intensely blood-red hue that can be conceived. There is nothing else about the sea that is red, and a considerable expanse of this, encountered by an early navigator who had not met with any similar phenomenon elsewhere, would seem warrant enough for its name.*

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* The depths are taken from the chart, but the greater part of the soundings are marked as having "no bottom," so the actual depths are certainly beyond this,—how much we know not.

Islands.—Though islands are numerous along both shores of the Red Sea, they are for the most part of inconsiderable size, and they have been included in the measurement of the area: their structure will come to be spoken of along with that of the rocks on the opposite shores.

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* Since the preceding remarks were in type I have fallen in with a paper by Ehrenberg on the bloody appearance of water, a translation of which appeared in 1831 in the tenth volume of Jamieson's Edinburgh Philosophical Journal. After enumerating instances quoted by the ancients of red snow, red rain, and rivers and seas covered with blood, he quotes a list of our experiences on these subjects in modern times. I take the following entire; he comes to the same conclusion as that which I have arrived at as to the origin of the name of the Red Sea:—

"In 1823 I was for a number of months at Tor, on the Red Sea, in the vicinity of Mount Sinai. On the 10th December I there observed the striking phenomenon of the whole bay which forms the harbour of Tor of a bloody colour. The main sea beyond the coral reef that encloses the harbour was, as usual, colourless. The short waves of the calm sea, during sunshine, carried to the shore a bloody coloured slimy mass, which it deposited on the sands, so that the whole bay, fully half a league in length, at the ebb of the tide exhibited a blood red border of more than a foot broad. I took up some of the water itself with glasses and carried it to my tent at hand on the sea shore. It was immediately discovered that the colouring was caused by small flakes, scarcely distinguishable, often greenish, sometimes of a lively green, but for the most part of a dark red colour, although the water itself was not stained by them. This very interesting appearance attracted my attention as explanatory of the name of the Red Sea, a name hitherto so difficult of explanation. I, for many days and with perfect leisure, accurately examined the appearances and made microscopical observations on the colouring mass. The flakes consisted of small spiral or longish irregular bunches of oscillatoriæ threads, which were enclosed in a gelatinous sheath, and the flakes neither resembled one another nor the threads in each flake. In the glasses placed beside me I observed that the flakes during the heat of the day and in sunshine floated together on the surface of the water. During the night and when the glasses were shaken they descended to the bottom. After some time they returned to the surface. The observation made by Dr. Englehardt on Lake Murten was very similar to this appearance, and the delineation of the single threads by De Candolle exhibits a very close relation to it. De Candolle informs me he has preserved no dried specimen of that substance, for which reason no comparison can be made. The gelatinous covering and the union of many threads into very small spiral groups give to the substance of the Red Sea a peculiar character, which entitles it to form a particular genus of alga. . . . . The appearance of the Red Sea was not permanent, but periodical. I observed it several times: on the 25th and 30th December, 1843, and on the 5th January, 1844."

Temperature.—The surface temperature of the Red Sea, agitated by the paddles of the steamers, varies from 60° to 85°. By a series of hourly observations made on it in April, 1840, when it ranged from 80° to 85°, it was in general from two to three degrees hotter than the air from midnight to dawn, and about as much colder from noon to sunset. Captain Newbold's observations for May, 1844, give from 82° to 84° as the midnight and noon temperatures, those of the air at the same hours being from 85° to 90°. The matter is one that has been but little attended to, though it is probable that the Red Sea scarcely differs in this from the outer ocean.

Appearance and Saltness of its Waters.—As the Red Sea is entirely surrounded by a hard, sandy, or rocky shore, without a rivulet, and scarcely a drop of rain falling into it from year to year, its waters are remarkable for their transparency and purity, even over a long expanse of shallows. Where the sea is deep and distant from the land, its colour is of the most intense blue, changing from greenish-blue to bluish-green, green, and light green, as the coral reefs approach the surface—the corals themselves being mostly white. It was long supposed to be considerably salter than the general ocean, a supposition now proved to be unsound. In 1837 Dr. Malcolmson found the water off Cossir of specific gravity 1·035, indicating a degree of saltness greater than that at Suez, but not so great as that of many parts of the Atlantic. The water at Mocha and Camran hardly at all differs from that of the outer sea. In 1848 Mr. Morris, engineer, obtained for me specimens of the water from seven different stations, nearly equidistant from each other all the way down: they were examined by Dr. Giraud, Professor of Chemistry at Bombay, and the following were the results:—

		Lat. ° ′	Long. ° ′	Sp. gr.	Saline Contents in 1000 parts.
No. 1.	Sea at Suez	29 40	35 2	1·027	41·0
2.	Gulf of Suez	27 49	33 44	1·026	40·0
3.	Red Sea	24 29	36 0	1·024	39·2
4.	Ditto	20 55	38 18	1·026	40·5
5.	Ditto	20 43	40 3	1·024	39·8
6.	Ditto	14 34	42 43	1·024	39·9
7.	Ditto	12 39	44 45	1·023	39·2

Dr. Giraud gives the following note of the saltness of the sea from a variety of other localities. From this it will be seen that the Mediterranean at Marseilles is of the same saltness as the Red Sea at Suez, while the Atlantic in the latitude of the Canaries is $\frac{4}{1000}$ more salt.

	Grs.	
Baltic	20·0	in 1000
Frith of Forth	30·0	,,
Boulogne	32·0	,,
Havre	36·0	,,
Bayonne	38·0	,,
Marseilles	41·0	,,
Atlantic, Canaries	44·0	,,

These experiments were made on water taken from the surface of the sea. We are ignorant of the character of the water in its depths, but have no reason to suppose it to differ materially from that at the surface.

Climate and Winds.—From the general conformation of its shores, the winds in the Red Sea for the most part blow in the direction of its axis, being for eight months in the year from the N.W., for the remainder from the S.E. The characteristics of the climate of the upper and lower portions of the sea differ, as may be expected, materially from each other, that of the middle portion partaking occasionally of both. The N.E. monsoon, which commences in October and continues till May or June, blows with considerable freshness in February, but is, as summer sets in, occasionally interrupted almost altogether. On entering the Red Sea it is deflected, and pursues a path almost at right angles to that which it had previously pursued, becoming a south-easterly wind as it rushes up the axis of the sea. Confined in a comparatively narrow compass, it blows with considerable violence, and is stronger towards the Arabian than the Abyssinian shore in the lower part of the sea. It is freshest in the end of October and beginning of February, and is sometimes felt as far up as Suez, so that generally by the time that it gets as high as Judda, lat. 21° 30′, it becomes for the most part light and variable. It slackens as it passes the Harnish and Zugar islands under the 14th parallel, where the sea begins to extend in breadth. Further to the northward it softens still more, till it is lost in the languid winds on the coral reefs of the Arabian coast, or turning to the westward, wanders away out towards the islands of the African shore, until, changing its course, it returns again into itself. In October and January the weather in the lower part of the sea is thick and hazy, obscuring objects until they are close at hand, and squalls and rain are frequent and heavy. Captain Ellowan states, that in December land and sea-breezes were prevalent on the Arabian shore, half way up the Red Sea, with occasional southerly winds; in January it was frequently squally, with thunder, lightning, and some rain in the southward, occasional squalls being experienced in February. On the African coast, in lat. 15°, the prevailing winds in March are westerly, drawing off from the land towards night, from the sea during the day. In April regular land and sea-breezes prevailed, the winds generally from the N., though twice or thrice from the S., and the weather often hazy. In May the wind mostly comes from the land, the sea-breezes becoming light, sand squalls being experienced towards the beginning of June.

When the south-easterly monsoon begins to blow in the north-westerly part of the Indian Ocean, north-westerly winds prevail in the lower half of the Red Sea, where they blow with considerable violence in June and July, becoming light and variable in August and September. As the time of their extinction approaches, there are sometimes calms of several days' duration experienced, when the sea-breezes become excessive. On the African shore, sea and land breezes are experienced towards the strait, with northerly winds nearly all the year round. The fine season prevails from August to October; showers, such as they are, are chiefly experienced from November to March. The winds from Suez to Judda are mostly northerly throughout the year, and occasionally blow with considerable violence. From December to April southerly winds are occasionally experienced in the Gulf of Suez, at times freshening into a gale, and blow for several days. Captain Carless tells us, that it is almost always stormy in the Gulf of Akabá, the squalls being dangerous and violent where the two gulfs unite. Captain Cruttenden states, that when he visited Senna in July, 1836, no rain had fallen, either there or at Mocha, for four years, but that during his stay heavy rains fell for nearly a month. These remarks are all taken from the writings of the officers on the survey, some of which still remain unpublished, and are mostly from the sailing directions of Captain Moresby. We have no regular meteorological observations from any part of the Red Sea higher up than Aden, where the evaporation amounts to about 7 feet annually. Off the peninsula of Sinai, according to the experiments of Captain Carless, it amounts to between 8 and 9 feet; and when the dryness of the desert winds is taken into account, the evaporation over its whole surface will probably be found to fall little short of 8 feet annually; and certainly not more than an inch of rain or rain-water is added in the course of the year; the showers, heavy as they are, which occasionally fall on its shores being drunk up by the thirsty sands which cover them all around.

Currents.—From the general character of the sea as just described, a very singular series of occurrences may be expected to make their appearance near the strait, to compensate an evaporation of nearly a quarter of an inch daily, or nearly 8 feet annually, over an area of 108,154 miles, or in all 165 cubic miles of water raised in vapour in excess of the little rain that falls. Were the geological theory true, that the water, concentrated at the surface, occasioned a deposit of salt at the bottom, the Red Sea must long ago have been transformed into a solid mass, and if the assumptions as to the capacity of the Red Sea be correct, the waters would be dried up in the course of a hundred years, were no water to enter from without. In the course of three thousand years (and for this time it has been known to us) it must have been converted into a solid mass of salt, had the whole saline matter, carried in from without by the current required to feed evaporation, remained within the strait. Yet we know that, in point of fact, it is, at the surface at all events, not one whit more saline than the outer ocean; and we have no reason to believe that its lower waters differ materially from those which float at the surface. The various officers of the survey were, from the commencement of their labours, struck with the extraordinary diversity of the currents within the Gulf of Aden. "My endeavours," says Capt. Haines in a paper prepared in 1849, "to reduce them to principles which might guide others have hitherto entirely failed, but I am at this moment not satisfied how the currents themselves are set in motion, whether by submarine impulse, by a change in the component parts of the water occasioned by different degrees of evaporation, or by the pressure of prevailing winds. At sea I have experienced a current running in circles, or in bands, 60 miles in extent, and have not unfrequently borne up, and set topmast studding-sails with a favourable wind, in order to escape the counter current, when, by observation, I have found the vessel in another stream out of the former current, and have hauled to windward again, and beaten fast sailers, which were working inshore." This corresponds almost word for word with the account given by Dr. Scoresby of the bewildering currents produced by the tepid waters of the Gulf-stream running N., and meeting the cold and heavy polar currents moving southward: the cause of both being the encounter of streams of water of different weight; the specific gravity of the two depending in the one case on the diversities of temperature, in the other on differences of saltness. The error into which those who assume the salting up of the sea, seem to have fallen, is that of supposing the water concentrated by evaporation to remain at the surface till close on the point of saturation, and then sinking only when ready to deposit its salt, whereas, in point of fact, the instant the upper waters become one atom heavier than those beneath them, they will sink down either till they reach the bottom, or meet with others of the same gravity as themselves. A mass of brine, by ever so little salter than the surrounding waters, may thus accumulate in the recesses of the sea, until it rises to the level of the Mocha barrier, when, by its own gravity, it will at once flow over, and produce an outward under-current, by which the whole mass of the sea will come to be discharged as it is concentrated. Between this and the upper inward-flowing current, required not only to supply the whole 165 cubic miles vaporized, but the vitiated water discharged, there will in all likelihood be a mass of stagnant water brought to rest by its upper and lower surfaces being acted upon in opposite ways by the conflicting currents. These things are matters of physical necessity, dependent on the first principles of hydrostatics, and not requiring experiment for their establishment. It seems more than probable that the Red Sea changes the whole of its waters at least once a year; and we may yet be able to determine the fact by observation. As it is, we know that a strong current sets along the coast of Arabia, towards Meckran and Scinde, then sweeping southward by the shores of Hindostan, where it is diluted by the enormous falls of rain, of which probably not less than 10 feet are discharged into the ocean annually from an area of 24,000 miles, or 40 cubic miles of water, it next crosses the Arabian Sea towards Zanzibar, and gives off its surplus vapour as it returns along the shores of Africa northward to the Red Sea, again to perform the task it originally accomplished. The whole amount of water, evaporated from the nearly rainless shores to the N.W. of the Arabian Sea, probably exceeds 400 cubic miles, the further deficiency being supplied by currents from the southward.

The Shores of the Red Sea.—Around the whole of the shores of the Red Sea is a belt of sand and gravel, sloping inward from high-water mark to a distance varying from some hundred yards to that of many miles. It abounds with shells and corals, identical with those in the sea itself, and is obviously an upheaved beach of comparatively modern date. It is not very easy to determine either the extent or the elevation of its landward margin, as a long series of upheavals appear in these parts to have followed each other, so that a much more minute survey than has hitherto been bestowed upon it, would be required before what belongs to each could be determined. I have found Red Sea shells scattered in profusion all over the Desert, between Cairo and Suez, at an altitude of 800 feet, and they are mentioned as existing at an elevation of at least 2000. Dr. Carter describes a cavern near Ras-Morbat, in southern Arabia, the floor of which is a few feet above high-water mark, the roof being 30 feet high, obviously excavated by the waves. The face of the cliff on a level with the roof is full of borings of lithodomi, and Dr. Carter supposes that it was formed whilst slowly emerging from the sea.*

There are many similar caverns in the interior; the roofs and floors of all are incrusted with sulphate of lime, as stalagmites and stalactites. The cliffs along the shore of Africa, towards the mouth of the Gulf of Aden, are found all pierced with similar caves, as I have no doubt those around the Red Sea would be found to be, were they examined; and I have come to the conclusion that the altitude of the most recent of these upheavals varies from 5 to 30 feet, being different at different points.

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* Geography of S.E. Coast of Arabia: Trans. Bomb. Asiat. Soc., 1851, p. 252.

During his investigations with a view to the construction of a canal between the Mediterranean and the Red Sea, Mr. Cubitt found the level of the two seas the same; and there can be little doubt that the bitter lakes in the isthmus at one time formed the head of the Red Sea. Mr. Stephenson has ascertained that the sea-shells in this district, as well as those on both the raised beaches in that neighbourhood, are the same as those now prevailing in the Gulf of Suez; so that, at a period comparatively recent, all the tertiary beds forming the bottom of the sea and the contiguous land must have been elevated from 12 to 18 feet. Historical events afford us a date within which this must have occurred. Six centuries before the Christian era, Darius Hystaspes completed a canal from the Nile, a little above Bubastes, to the Red Sea near Patamos; it was in some places 150 feet wide and 30 feet deep, and was navigable for vessels of considerable burden; while the Nile which supplied it was high, the waters serving for irrigation. The vicinity of several important cities, the ruins of which are still scattered around, indicates that the district at this period was possessed of great fertility and a large population. Within three thousand years, then, the alteration of level must have occurred which rendered it impossible longer to supply the canal from the waters of the Nile. In this view I have adopted both the facts and the inferences of Mr. Cubitt, Mr. Stephenson, Capt. Newbold, Miss Corbaux, and Mr. Glynn, not having crossed it myself;* but I had come to exactly the same conclusions, and published an account of these four years before the earliest of the writings referred to appeared. In Kattywar in Western India we have a proof of the same thing, near the Runn of Cutch, where the ruins of a city, known to have existed less than three thousand years ago, are now found 15 feet beneath the surface of the ground—8 or 10 feet above high-water mark. Within this time a descent of at least 20 feet must have occurred to permit this mud to be deposited, the whole having reascended to its present level probably about the same time when the Runn of Cutch ceased to be an inland sea, by reason of the elevation of its basin. We are now minutely acquainted with the character of the Isthmus of Suez, destined, it is to be hoped, at no great distance of time to be traversed by a canal or railway connecting the two seas together.[*]

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* Capt. Newbold's Visit to the Bitter Lakes, Isthmus of Suez, Trans. Roy. Asiat. Soc., 1845, vol. viii. p. 355; Mr. Glynn on the Isthmus of Suez, on Ancient Canals of Egypt, Institution of Civil Engineers, 1852; Miss Fanny Corbaux's Letters in the "Athenæum," 1852.

It is singular that we should know so little that is authentic or accurate of the Wadi Arabá. or the region which intervenes between the Gulf of Akabá, the other terminal point of the Red Sea, and the great depression of Palestine, considering its perfect accessibility and the frequency with which it has been traversed. Even the little knowledge we flattered ourselves that we possessed, has now vanished. A writer in the 18th volume of this Society's Journal, basing, as I had supposed, his conclusions on well-established facts, had placed its length at 105 miles, and its summit level at 495 feet; but Capt. Allen, R.N., has since shown[†] that we are altogether ignorant both of the altitude and position of its water-shed. We do not profess to know anything of its geology, or the age of its upheaval. The islands in the Red Sea doubtless afford abundant evidence of these various changes of level; but, with the exception of the volcano of Gibel-Teer, and of those described by Ehrenberg, in the neighbourhood of Ras-Mahommed, scarcely one of them has been examined or described in modern times. The "Two Brothers," in lat. 26° 20′ N., long. 34° 45′ E., are set down in the chart as coral islands, about 60 feet above the level of the sea. The sea immediately around them sinks at once to 50 fathoms. The Red Sea, around its whole circuit, is walled in by vast masses of mountain, which, down to Judda, in 21° 30′ N. latitude, approach close to its shores. On the African side, down to the 16th parallel, isolated hills alone skirt its borders; the higher ranges, 40 or 50 miles off, are seldom seen at sea; and on the opposite shore, between the same parallels, the land slopes gently in towards the interior of Arabia. The rocks chiefly consist of nummulite limestone—a portion of the vast band so admirably described by Sir Roderick Murchison, as stretching all the way, in one unbroken line, from the Bay of Biscay to the shores of Aracan, for nearly one-third of the circuit of the globe. From the parallel 16 to 12 the mountains on both shores and the islands in the middle of the Red Sea are volcanic. Gibel-Teer, in lat. 15° 30′, is still smoking, as it has been since 1774, when visited by Bruce, by whom it is set down as 500 feet in elevation. Dr. Kirk makes it 300 feet; the surveyors place it at 900: so little do we know of a volcano passed by our steamers at least four times every month. A violent eruption, of short continuance, took place in one of the Zugar islands, lat. 15°, in 1846, which was fortunately seen from different points of view by steamers passing in opposite directions, but it has never since been visited. A range of hills, above 14 miles from the shore, to which it is nearly parallel, is laid down in the chart as volcanic on the African side, with a similar range of greater magnitude and of the same character, extending from lat. 12° to lat. 15° 30′ on the Arabian coast. Dr. Kirk describes these as extending for about 300 miles to the westward; so that this vast volcanic field, which has scarcely been so much as noticed by geologists, occupies probably an area of above 10,000 square miles, without interruption; and is perhaps the third or fourth in point of extent on the surface of the globe. The only one of all its volcanoes with which we are somewhat acquainted is that of Aden, in the crater of which our troops are quartered. It has been so often described that it is not necessary here to refer to it, further than to state that it has clearly been submerged and elevated again from the waters, since the latest period of its activity. Up to the altitude of 500 feet it is thickly strewed with sea-shells mixed with scoriæ and volcanic ashes; and in the bottom of the crater and all around the margins of the peninsula are masses of shells and gravel, the same as now prevail in the sea around, and exactly similar to those on the raised beaches of India and of Suez.

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[*] The Isthmus of Suez appears at the southern extremity to constitute the trough or hollow which at one time formed the basin of the upper part of the Red Sea. Here it is walled in on both sides by mountain lands, which rise into loftier regions towards the peninsula, and into rounded hills of soft limestone in the direction of Cairo. It is with the level plain alone we are at present concerned: this was first carefully surveyed by the French engineers in 1799, and the error was then committed of supposing the level of the Red Sea 30 feet above that of the Mediterranean. Although its suitableness for canal purposes had frequently been discussed, and it had been examined by Linant and other European engineers resident in Egypt, fifty years elapsed before the mistake of the French was discovered, when Mr. Stephenson made his survey in 1848. The distance by the shortest line from the Mediterranean to the Red Sea is 75 miles; the length of the canal proposed by the French 92 miles. From the high-water mark at Suez to the bed of the bitter lakes, a distance of 13½ miles, the ground is almost even; it is covered with shells and sea-gravel, and rises from 3 to 12 feet above the highest tide. Here a depression, averaging about 16 feet, commences and extends for a distance of 27 miles; the surface of the bitter lakes themselves, which appear fragments of the Mediterranean or Red Sea lowered by evaporation, being 54 feet. From this to the Mediterranean the ground is low and marshy, abounding in pools of salt water. Over the whole of this tract the shells are identical with those now found in the Red Sea, which was probably here united with the Mediterranean much within the historic period. The question of its practicability for a canal was, until 1850, argued under two assumed difficulties, which have now both vanished—the navigation of the Red Sea before the introduction of steamers, and the difference of the levels of the two seas. The French engineers considered a canal perfectly practicable, and estimated the expense at 700,000*l.*; and Mr. Maclaren, who first presented us with their views in an English dress, concurs with them in opinion. Linant and Henderson agree as to the practicability, but double the charge. Capt. Vetch considers the canal will cost 2,500,000*l.* Capt. Glascock and Mr. Galway regarded it as wholly impracticable. Col. Chesney, M. Prony, M. Michel Chevalier, consider the canal practicable in a country where labour was cheap, and no physical difficulties existed. It seems singular that any doubt should be suffered to remain on a question of such supreme importance. The introduction of screw-steamers would permit the voyage to be made in one vessel from Europe to India; the distance between the two seas being calculated at 20 hours with a speed of no more than 5 miles an hour. At present, coal, which must be carried on camels' backs across the desert, costs 10*l.* a ton at Suez; ships being thereby compelled to carry the bulk of their coal along with them from Aden and back, to their very great inconvenience.

See Mr. Maclaren's paper, Edin. Phil. Journ., 1825; various pamphlets published in 1842 and 1843; the Reports of the Society of Civil Engineers for 1850-51, Miss Fanny Corbaux' Letters in the Athenæum, 1851-52; Captain Newbold's visit to the Bitter Lakes; Journal of the Royal Asiatic Society, London, 1846.

[†] Trans. of the Royal Geographical Society, 1853, vol. 23, p. 166.

Note by Captain Haines.—The latitude of the Straits of Babelmandeb I do not think correct. I found soundings all the way across just outside the Red Sea; greatest depth 198 fathoms.

There are, no doubt, many reefs in existence not yet discovered: I reported one in April last, upon which an Arab ship struck.

The height of the water within the Red Sea depends upon the seasons; and after strong N.N.W. winds the shoals in the north part are dry in many places: even the shoals in the centre are influenced in the same way. The Durable Shoal can be landed on *at times.*

In January and February it more frequently blows strong from S.S.E. up the sea in the lower part, and the contrary from N.N.W. in June, July, and August. —*S. B. H.*

VIII.—*Extract of a Letter from Captain Spratt, R.N., on Crete.*

Communicated by Colonel LEAKE, F.R.G.S.

Read March 13, 1854.

I MADE an interesting discovery in the western part of the island, viz., that it has been subject to a series of elevations, amounting to the maximum of 24 feet 6 inches, which occurs near Pœkilassos and Suia. In the middle of the island, at Messara, the Fair Havens, and Megalo Kastro, there is none. The eastern end of the island has dipped a little. The upheaving is towards the western end. I had observed it to be about 7 feet in Suda Bay many years ago; but supposed it to be of a time prior to history, although there was a freshness in the markings which might have induced me to suspect they were of a more recent date. When at Kissamo, I observed that the ancient mole was remarkably high out of the water, and the port almost choked by sand. But the latter is so common an occurrence that it did not open my eyes, although the height of the naked unhewn rocks which formed the mole ought to have done so. On going to Phalasarna I looked for its ancient port, mentioned by Scylax, and in the Stadiasmus as the Emporium; but I could find no artificial work in the sea. There is, however, a long ledge of rocks, or rather an islet which lies off it, helping to form a natural but not an artificial harbour. This satisfied me in part, till, on examining the ruins, I saw in the plain a square place, enclosed by walls and towers, more massive and solid than those of the city. Pashley describes them without having been sensible of their purpose. I was instantly impressed, for several reasons,